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SPOKANE COUNTY

UTILITIES DEPARTMENT
William R. Dobratz, P.E., Director

A DIVISION OF THE PUBLIC WORKS DEPARTMENT
Dennis M. Scott, P.E., Director

January 30, 1995

RECEIVED
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SUPERFUND REMEDIAL BRANCH

Mr. Michael Kuntz
Project Manager
Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600

Regarding: Response to Ecology December 5, 1994 Comments On Draft Aquifer Management, Quality Assurance, Field Sampling Plans, and Computer Simulation

Dear Mr. Kuntz:

Enclosed you will find our consultant's, Landau Associates, response to your December 5, 1994 comments and subsequent conference call on January 12, 1995. Our hope is that this submittal will assure Ecology that the system that is in place and operational meets the objectives of the Consent Decree and that we are well on our way to a final clean up at the Colbert Landfill. If there are matters yet to be resolved, clarified, or needs further discussion, Spokane County and its consultant are prepared to meet with Ecology and EPA to answer any questions.

Sincerely,

Dean S. Fowler, P.E.
Project Manager

mp

cc: Neil Thompson, EPA

LANDAU
ASSOCIATES,
INC.
Environmental and Geotechnical Services

TECHNICAL MEMORANDUM

TO: Dean Fowler, P.E., Spokane County

FROM: Lawrence D. Beard, P.E., Landau Associates (MCM for)

DATE: January 30, 1995

RE: **RESPONSE TO ECOLOGY AND EPA COMMENTS ON THE INTERIM DRAFT AQUIFER MANAGEMENT, QUALITY ASSURANCE AND FIELD SAMPLING PLANS, AND COMPUTER SIMULATION FOR THE COLBERT LANDFILL REMEDIAL ACTION**

INTRODUCTION

This memorandum presents Landau Associates' responses to Washington Department of Ecology (Ecology) and U. S. Environmental Protection Agency's (EPA) comments on the above referenced plans for the Colbert Landfill Remedial Action presented in Ecology's December 5, 1994 letter. Additionally, comments were provided in the letter on the numerical groundwater flow model presented in Appendix E of the Final Extraction Well Plan (Landau Associates 1992a), which was previously reviewed and approved by Ecology and EPA. A telephone conference was held on January 12, 1995 to clarify some of the comments contained in Ecology's December 5 letter. Conference call participants were Neil Thompson (EPA), Mike Kuntz (Ecology), Bill Wedlake and Dennis Scott (Spokane County), and John Markus and Larry Beard (Landau Associates).

Both general and specific comments are presented in Ecology's letter; however, no specific comments were received on the Quality Assurance Project Plan (QAPP). We interpret the lack of comment to indicate acceptance by Ecology and EPA of this document.

The majority of the substantive comments relate to the Aquifer Management Plan and the groundwater flow model. Based on the comments presented in Ecology's December 5 letter and the subsequent telephone conference, the primary concerns of Ecology and EPA appear to be:

- Is the computer model valid for compliance monitoring?
- Are some of the compliance monitoring wells in the interception system capture zone?
- Is the groundwater compliance monitoring system adequate to track the migration of the plumes?

23107 100th Avenue W. • P.O. Box 1029 • Edmonds, WA 98020-9129 • (206) 778-0907 • FAX (206) 778-6409

We understand that the first question was resolved during the conference call. It was clarified by Landau Associates that the computer model is not intended for use in compliance monitoring, but as a tool for system operation and optimization, independent of what would be required based on Consent Decree compliance requirements. It is intended that compliance monitoring be consistent with the Consent Decree requirements, which specify groundwater quality data as the basis for operation, adjustment, and modification to the remedial action. We believe this is reflected in the Aquifer Management Plan, but will modify the plan to clarify this issue. In our opinion, the groundwater flow model is a useful tool for comparing predicted-to-observed aquifer response to pumping, and as a basis for making adjustments to the interception/extraction systems.

The second concern (are some of the compliance monitoring wells in the interception system capture zone?) is more difficult to address, because there are no specific criteria regarding how far outside of a predicted capture zone a downgradient well must be located to provide adequate assurance it represents downgradient water quality. The downgradient wells must be located a sufficient distance from the interception system capture zone to ensure that these wells are representative of downgradient conditions. However, these wells must be located close enough to the capture zone to rapidly detect plume breakthrough so that necessary corrective actions can be quickly implemented. This is one of the primary reasons the well locations and basis for design were submitted to EPA and Ecology for review and approval prior to construction of the groundwater interception and compliance monitoring systems (Landau Associates 1992a and 1992b). It is specifically stated in the Groundwater Monitoring Plan that some of the compliance monitoring wells were near or within the capture zone (page 2-5, 4th paragraph), and the basis for these locations was discussed in the Plan. Spokane County has attempted to address Ecology's and EPA's comments regarding the locations of compliance monitoring wells herein, but we are concerned that the position of the regulatory agencies (regarding acceptance of the monitoring well locations) has changed without any substantive change to known site conditions.

The third concern (is the groundwater monitoring system adequate to track migration of the plumes?) should be adequately addressed by the responses to comments provided in this memorandum. In our opinion, the groundwater compliance monitoring system adequately tracks the leading edge(s) of the plume(s). The supplemental data provided by the domestic well monitoring program provide additional downgradient water quality data and a significant amount of data from the lateral and upgradient boundaries of the plumes. We recommend that the presentation of the domestic well data be integrated into quarterly reporting for remedial action operation.

The following sections of this memorandum present the EPA/Ecology comments with Landau Associates' responses in italics immediately following each comment. We do not recommend specifically modifying and reissuing the plans until all the issues are resolved and concurrence is achieved between Spokane County and the regulatory agencies.

Response reqd

GENERAL COMMENTS

1. Comparing measured drawdowns to computer simulated drawdowns for the purposes of monitoring and evaluating the groundwater extraction system is not acceptable at this time. Thus, the current monitoring "program" is not acceptable. We believe the current program may present a potential risk to human health.

   OK

   As stated in the Introduction to this memorandum, groundwater quality data from compliance monitoring wells will be the basis for evaluating system performance with respect to the Consent Decree requirements. We understand that this clarification adequately addresses this concern. However, we request clarification from EPA and Ecology as to whether discussion of the use of 'target drawdowns' as an initial guide for establishing hydraulic control can remain in the Aquifer Management Plan, provided it is clarified that achieving these drawdowns is not a basis for establishing Consent Decree compliance. However, we recommend changing the text to clarify that groundwater quality data will form the basis for ultimately determining the required drawdown for containment.

   response OK *

2. The computer simulation of the upper and lower aquifer is invalid for compliance monitoring purposes due to inadequate calibration data, unsubstantiated assumptions and because model boundaries, critical assumptions, and calculation for numerous input parameters can not be verified.

   OK

   We anticipate that the responses to specific comments on the Aquifer Management Plan and computer simulation will alleviate some of the stated concerns. However, we understand that the previous clarification regarding the intended use of the groundwater flow model results during operation addresses the overall concern .

3. As reported, the location of three of the south system monitoring wells and two of the east west system monitoring wells do not satisfy Consent Decree requirements. Due to inaccuracy in the computer simulation, and other factors, there is high probability that all the other monitoring wells do not meet Consent Decree requirements for monitoring well location. This presents a risk to human health.

   As stated in the Introduction to this memorandum, the Groundwater Monitoring Plan (Landau Associates 1992b, Page 2-5, Paragraph 4) identifies the wells near or within the capture zone, and the basis for these locations is discussed in the text. The Groundwater Monitoring Plan was reviewed and accepted by Ecology and EPA. It is our opinion *that the basis for placing the wells at these locations is still valid, and we request that EPA and Ecology review this information and reconsider their comment.*

In our opinion, the compliance monitoring wells not identified in the Groundwater Monitoring Plan as being within or near the capture zone, are outside the capture zone. This conclusion is based on the assumption that drawdowns consistent with those predicted by the groundwater flow model are maintained. The capture zones shown on various figures represent the maximum anticipated capture zone for the identified operational conditions.

4. Contaminated groundwater appears to be migrating unchecked to the east and northeast of the landfill in the lower aquifer. As simulated by computer, the East/ West extraction appears to allow breakthrough of contaminated [*sic*]. The South system monitoring wells do not provide adequate coverage. These conditions presents a risk to human health.

   There has been migration of some of the constituents of concern (primarily TCA) at concentrations significantly below the performance standards to the northeast and southwest of the landfill in the lower aquifer since completion of the Phase I Engineering Report. However, we are unaware of migration in these directions at concentrations of concern. Figures 1 and 2 of this memorandum show the present extent of detectable concentrations of TCA and concentrations above the TCA performance standard of 200 ug/L for the Upper and Lower Aquifers, respectively. Shown on Figure 3 and 4 of this memorandum are groundwater monitoring wells and domestic wells presently in the domestic well monitoring program. In our opinion, these data, in conjunction with the Upper and Lower Aquifer model-predicted capture zones, indicate that concentrations above the performance standards will be captured, and that adequate monitoring is provided for the Upper and Lower Aquifers plume boundaries. Given this additional information, we request that the regulatory agencies identify whether these data adequately address their concerns, and if not, the specific areas where they believe additional information is needed. We also refer the commentor to Sections 4.2.6 and 4.3.2.2 of the Phase I Engineering Report (Landau Associates 1991) for a discussion of the probable mechanisms causing the anomalous migration of constituents of concern to the northeast of the landfill. (pumping)

OK

SPECIFIC COMMENTS

AQUIFER MANAGEMENT PLAN

1. Although the MODFLOW and PATH3D simulations were a tool for siting monitoring wells, those simulations, in their present form, are not suitable for evaluating compliance for ground water monitoring, and ground water remediation, as indicated in the following comments.

   In regard to compliance for groundwater monitoring and groundwater monitoring [*sic*], the County would have two options: 1) bring the data base up to scientific standards, confirm and validate the input parameters and re-run the model with updated data, or 2) propose an alternate means of evaluating compliance for groundwater monitoring and groundwater remediation.

Ok *As previously stated, groundwater quality data from compliance monitoring wells will be used the evaluate compliance with Consent Decree groundwater quality requirements. The groundwater model results will only be used as a tool for assessment and (potentially) adjustment of groundwater extraction rates.*

2. As depicted in figure 7-4 of the management plan, a portion of the groundwater plume in the lower aquifer is migrating to the east and northeast of the landfill. This migration route runs counter to groundwater flow direction depicted in Figure 7-2. In attempting to compare figure 7-4 and 7-2, (groundwater flow), and to figure 7-7 (groundwater capture), we conclude that the contamination is not being captured. We do not believe the extraction system will capture the plume. Also, it appears as if this contamination is in a different geologic formation than the formation containing the extraction wells. Structural geology or domestic water use may be factors in this migration.

The migration of constituents of concern to the east of the landfill is discussed in the Phase I Engineering Report (Landau Associates 1991, Section 4.3.2.2). It is also noted therein that concentrations east of the landfill have decreased since their initial detection (see Figure ER-4.40), and that no hydrologic units were identified east of the landfill that are sufficiently transmissive for effective groundwater extraction (see Section 5.1). This information was the basis for not placing extraction wells to the east of the landfill, and these decisions were reviewed and approved by EPA and Ecology. Although we concur with the regulatory agencies that it is important to track groundwater quality in this area to confirm that conditions remain consistent with the original conclusions, we are unaware of any data collected to date that indicates otherwise.

data confirming position?

When was the last time groundwater was analyzed to track this plume? What is the County's opinion as to the reason for migration of this plume: How far is this plume expected to migrate" What steps will the County take to mitigate this plume and what is the schedule for these steps?

As shown on Figures 2 and 4, the boundary of the plume is being monitored by the Consent Decree compliance and domestic well monitoring programs. Figure 4 also presents the monitoring schedule for domestic wells; including those in the landfill vicinity. In our opinion, the conceptual model presented in the Phase I Engineering Report (Figure ER-4.23) still represents the most likely mechanism for the migration of constituents of concern east and northeast of the landfill. Because the concentrations for constituents migrating beyond the previously defined boundary of the affected area are below the performance standards, it appears that continued monitoring is the only action appropriate at present.

3. As reported in figures 7-5 and 7-6, the location of south system monitoring wells CD-31, CD-34, and CP-S3 are within the capture zone, and therefore do not meet Consent Decree requirements for the location of compliance monitoring wells. Consent Decree requirements for the location of south system monitoring wells are identified on page V-1 of the Decree.

The Decree requires that monitoring wells are to be located downgradient of the capture system (i.e., outside the capture system). This location provides for a determination of water quality entering the clean portion of the aquifer, and also provides a measure of protection for downgradient receptors that may be exposed to contaminants of concern that get through the system. Wells CD-31, CD-34 and CP-S3 monitor groundwater that is captured, treated, and discharged to the Little Spokane River. Monitoring wells in the capture system do not provide a measure of protection for downgradient receptors, and will not count as downgradient monitoring wells.

What is the County's assessment on the location of these monitoring wells in the capture zone? In making the assessment please provide all calculations, and assumptions. If these requests are not satisfied we will move to have the wells replaced with true downgradient wells due to concern over public health.

As previously discussed, the Groundwater Monitoring Plan (Landau Associates 1992b) specifically addresses this issue on page 2-5. In our opinion, the bases for the well locations are still valid. We request that the regulatory agencies review the referenced section of the Groundwater Monitoring Plan and identify whether it addresses their concern, and if not, identify the reasons for changing their position subsequent to reviewing and approving the Groundwater Monitoring Plan and the quantitation methods appropriate for implementation. *

4. Using figures 7-5 and 7-7, the location of east\west system monitoring wells CD-44 and CD-45 are located in the capture zone, and therefore do not meet consent decree requirements. These wells do not monitor aquifer return water, but water that is discharged to the Little Spokane River. The monitoring requirements for the location of the west system monitoring wells are identified on page V-13 of the Decree. The health issue and compliance conditions of the above comment apply here.

   What is the County's assessment on the location of these wells in the capture zone? In making the assessment please provide all calculations and assumptions. The replacement condition of the above comment applies here. *

   Please see response to the previous comment.

5. We also conclude, based on enclosed comments, that all the other south system monitoring wells are probably in the capture zone, and that the monitoring wells of the east/west system have a very high probability of being in the capture zone. Consequently, none of these monitoring wells meet Consent Decree requirements for location because of:

   A. the wells are either located in the capture system or are in very close proximity to the boundary of the capture system;
   B. the margin of error in the computer simulation would include the wells in the capture system; and,
   C. a perceived absence of reported or identified concern over locating the monitoring wells within the capture system.

   What is the County's assessment of the location of these wells in relation to the capture systems? In making the assessment please delineate an upper limit and lower limit to the capture systems shown on Figure 7-6 and 7-7. Base the limits on an error analysis of the computer simulation, and any other technique, or information used in depicting the capture zones. Also, please note in the record where the County indicated concern over placement of the wells in the capture zones, or took measures to see that wells were not completed in capture zones. If the requests in this paragraph are not satisfied we will consider all wells to be within the capture zones, and will move to have all wells replaced with true downgradient wells due to concern over human health.

As previously discussed, specific wells were identified as being within, or in close proximity to, the capture zones for the South and West Interception Systems in the Groundwater Monitoring Plan (Landau Associates 1992b). All compliance monitoring wells were graphically represented relative to the capture zones in this document as well. The Groundwater Monitoring and Extraction Well Plans were submitted to Ecology and EPA for review and approval to obtain their concurrence regarding basis of design for, and placement of, the extraction and compliance monitoring wells. Ecology and EPA reviewed, commented on, and approved these work plans. It is unclear what more could have been done by Spokane County to identify the proposed relationship between the model-predicted capture zone and the proposed monitoring well locations. The capture zones presented on Figures 7-6 and 7-7 of the Aquifer Management Plan, and Figures 2-1 and 2-2 of the Groundwater Management Plan, represent the maximum capture zone predicted based on the upper and lower bound flow scenarios presented in Appendix B of the Extraction Well Plan. As a result, it is our opinion that the capture zone illustrated represents the maximum extent of capture, and locations outside this area are appropriate for downgradient monitoring. Thus, the capture zone represented already incorporates the margin of error needed to locate the wells outside the capture zone. Landau Associates did not retain all of the particle tracking printouts used to develop the capture zone represented on the report figures, but can recreate these simulations, if requested by the regulatory agencies.

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It should be noted that the South Extraction System was reduced from 5 to 4 wells due to the more limited extent of contamination to the east that was observed during well construction (and subsequent groundwater monitoring) than originally modeled. This change reduces the overall pumping rate required to obtain capture, and consequently, the extent of downgradient capture. This further reduces the potential that the capture zone extends beyond the downgradient monitoring wells.

ok

6. The reported groundwater data must serve to answer two fundamental questions:

   A. What impact does the extraction system have on the amount and availability of local groundwater supplies; and,
   B. How efficiently are the extraction systems capturing the contaminant plumes?

The Aquifer Management Plan should address these two questions by describing the "hands on" methodology used by the County to collect, synthesize, manage, evaluate and report the data. Specific references to methodology in other approved plans or the Consent Decree is acceptable. The frequency and the depth and intensity of reporting should be described. We suggest a section in the plan be devoted to each of these questions. It may be worthwhile to consider a data management plan.

will it be?

It is anticipated that the quarterly reports (the first one, 3rd Quarter 1994, having recently been submitted to Ecology and EPA) will serve as the primary reporting mechanism for aquifer management and other operational data. The aquifer management plan can be expanded to accommodate additional discussion regarding the procedures for collection, synthesis, management and evaluation of the data. The impact on local groundwater supplies will be assessed based on regional drawdown resulting from the remedial action groundwater extractions.

Ok hydraulic efficiency

System efficiency with respect to plume capture will be evaluated based on maintaining compliance with the Consent Decree groundwater quality criteria. It was intended that the comparison of model-predicted and observed drawdowns would be used to evaluate extraction system hydraulic efficiency, but it is not now clear whether this approach is acceptable to Ecology and EPA. If not acceptable, we request that the regulatory agencies provide some suggestions as to what an acceptable approach to evaluating system efficiency would be.

response is ok

7. Regarding question B the Consent Decree defines baseline concentration, operational control criteria, evaluation criteria and adjustment control criteria, but the Decree does not state how these concepts are managed and reported. How will the County manage and report these concepts?

2 yrs in CD Ok

Once the requisite 2 years of groundwater quality data are obtained, operational and control criteria will be calculated (see response to comment 10 for a description of calculation methodology), and the calculations submitted to Ecology and EPA for review and concurrence. Subsequent compliance monitoring data will then be compared to these criteria, in addition to the evaluation criteria, to identify any criteria exceedences. These criteria comparisons will be presented in the quarterly reports for the review of Ecology and EPA. Criteria exceedences (if any) will be addressed on a case by case basis with Ecology and EPA. The Aquifer Management Plan will be amended once operational and adjustment control criteria are developed to reflect the new criteria.

8. Regarding the list of compliance monitoring wells in table 7-5, wells CD 45, C1, C2, C3 and CD 48, C1, C2, and C3, are proposed to be utilized as both downgradient and cross gradient wells. This is not acceptable because downgradient and cross gradient are distinctly different phenomenon. In summary, the dual purpose of the above wells to serve as both downgradient and cross gradient wells is not acceptable.

   Our position is that new wells will have to be installed to meet the requirements. What is the County's position regarding using wells as both downgradient and cross gradient? What is your proposal for resolving this matter? In the absence of a reasonable proposal we will move to have new wells installed to meet the requirements.

   The use of monitoring wells at locations CD-45 and CD-48 as both downgradient and crossgradient compliance monitoring wells is discussed in the Groundwater Monitoring Plan (Landau Associates 1992b, Section 2.2, page 2-6). The final plan incorporates additional language to address the second comment in Ecology's April 27,1992 comment letter, which referenced this issue. Additionally, the proposed text change was submitted to Ecology and EPA for review in Landau Associates' June 17, 1992 response letter, prior to incorporation into the final plan. In our opinion, the basis for utilizing these wells

Once we approve can we change our minds?

as identified in the Groundwater Monitoring Plan is still applicable. We request that Ecology and EPA review the applicable section of the Groundwater Monitoring Plan and the associated correspondence, and inform Spokane County whether it adequately addresses their concern. If not, Ecology and EPA should identify what has changed since their prior review and approval to warrant modification to the system.

9. In figure 7-1, the solid contours near the landfill indicate groundwater flow that is directed toward the bluff face over looking the Little Spokane River. The solid contours indicate flow to the River. The dashed contorts [*sic*], many of which rely on a single domestic well for control, indicate the flow does not enter the river but bends away and flows parallel to the bluff face and the river. Our review of cross sectional data and permeability map data does not provide a reason for the change in flow direction represented by the dashed contours.

What is your hydrogeologic reasoning for flow from the landfill heading toward the bluff face, and then bending away from the bluff face to flow parallel to the bluff face? Given the information in the above comment, why could there not be a great amount of contamination leaving the landfill and flowing directly into the river?

Ok?

The hydrogeologic characterization that is the basis for Figure 7-1 (and Figure 7-1, itself) is presented in the Phase I Engineering report (Landau Associates 1991, Section 4). Landau Associates concurs that a portion of the discharge from the Upper Sand/Gravel Aquifer is toward the Little Spokane River. This is reflected in the Phase I report, and is evidenced on Figure 7-1 by the presence of springs along the western aquifer boundary. However, the groundwater elevation data, the topography of the top of the Lacustrine Aquitard, and the plume geometry strongly support a southerly direction as the primary direction of flow. As shown on Figure 7-3 of the Aquifer Management Plan (and Figure 1, herein) constituents of concern are present near the river west of the landfill, but the concentrations are below the performance standards. It does not appear necessary to modify Figure 7-1 based on this comment; the existing contours appear to best reflect groundwater flow, although we acknowledge that limited data are available along the western aquifer boundary. The commentor is referred to Section 4.2.3.1 of the Phase II Engineering Report for a more complete discussion of the nature and extent of the Upper Sand/Gravel Aquifer. I?

10. The methodology for the determination of the baseline groundwater quality concentrations determined for downgradient compliance monitoring wells from the first two years of groundwater quality data is not identified or developed. The Consent Decree describes only the frequency of monitoring for baseline determination. What methodology is proposed? (i.e., averaging all the values, or taking the highest value, etc.)

Ok

The Consent Decree scope of work (Section V.A.2b, page V-5) specifies that the baseline concentration will be calculated as the average of the time-averaged concentrations over the two year period. Spokane County will use this method, unless another method mutually agreeable to Spokane County and the regulatory agencies is developed. It does not appear necessary to modify the Aquifer Management Plan based on this comment.

11. Regarding Figure 7-2, showing lower groundwater contours we can not determine the control used to construct the contours. Figure 7-2 contains five types of wells and many of them were constructed after the winter of 1990 when the data for the contorts [*sic*] were collected. The figure is unacceptable. Please provide for the management plan a groundwater contour map of the lower aquifer showing only the wells that were used to construct the map. This request is not inconsistent with standard procedures for reporting ground water contours.

Ok

Figure 7-2 will be modified to eliminate the wells that were not used to develop the groundwater elevation contours.

12. Regarding Figure 7-3, We can not determine the control used to construct the extent of contamination. Four types of wells are noted on the figure and there are no dates for groundwater analysis on the figure. The figure is unacceptable. Please provide for the management plan a figure showing only the wells used for constructing the extent of contamination, the dates the samples were taken, and the level of contamination reported. This request is not inconsistent with standard procedures for reporting the extent of contamination.

Check

We propose to replace Figure 7-3 with Figures 1 and 3 presented herein. We request that Ecology and EPA indicate whether this is acceptable, and if not, what additional information is needed.

13. Regarding figure 7-4, the issues and conditions of the above comment apply.

Check

We propose to replace Figure 7-3 with Figures 2 and 4 presented herein. We request that Ecology and EPA indicate whether this is acceptable, and if not, what additional information is needed.

14. Regarding both figures 7-3 and 7-4, the period for which the data was gathered is not identified. If the period for data gathering exceeds six months, the data would very likely be influenced by seasonal variation in groundwater. Standard operating procedures for contaminant distribution maps usually require the data be gathered within a six month period or less. What is the period for gathering the data which is plotted on figures 7-3 and 7-4? Are seasonal variations in groundwater quality factored into figures 7-3 and 7-4?

See responses to comments 12 and 13. To the extent practicable, the data presented on Figures 1 and 2 are from a six month period. However, some data (as identified on the figure) are outside of this time frame due to the limitations of available data. However, the data are adequate to meet the intent of the figure, which is to identify the extent of the affected area to the reader. Although no detailed evaluation has been performed on the impact of seasonal fluctuations in groundwater quality, no obvious relationships are apparent from a qualitative review of the data.

15. Regarding figure 7-3, consider dividing it into northern central and southern regions with the two dividing lines between the regions being: 1) Woolard Rd- Norwood Road, and 2) a line parallel to the first dividing line, and located 1000 feet south of Big Meadows Road.

In this example the southern region would appear to contain over thirty monitoring points for the constituents of concern. The central region has about six points, and the northern region has three but there proximity renders them monitoring a very small area.

Given the above, the distribution of monitoring points biases the data so that more contamination would be expected to be found in the southern area.

What is the County's opinion on the distribution and number of data points biasing the measured distribution of contamination? What is the justification of having so many monitoring points away from the source, and so few near the source?

The monitoring density is a function of where monitoring wells were installed to identify the location and track the migration of the plume, and where domestic wells are present. Because the greatest concern is locating and monitoring the leading edge of the plume, the increased density of monitoring points to the south appears appropriate. Because of the reduction in concentration near the landfill in the Upper Sand/Gravel Aquifer over the years, resulting in the low concentrations now present in this area, additional monitoring points in this area do not appear necessary.

OK

16. The text reference to Figures 7-8 and 7-9 does not provide a pumping rate or any parameters or assumptions regarding drawdown. Please provide the rate, parameters and assumptions. Why do these estimated drawdowns provide a reasonable approximation of anticipated values?

These figures were taken directly from Appendix B of the Extraction Well Plan (Landau Associates 1992a), and will be referenced as such in the Aquifer Management Plan, along with a description of the pumping rates and aquifer parameters associated with the drawdown. The reader will be referred to the Extraction Well Plan for a more complete description of model development, including assumptions. A more extensive discussion in the Aquifer Management Plan would be inappropriate. In our opinion, these drawdowns represent a reasonable approximation of anticipated values because the groundwater flow model is based on relatively extensive and good quality hydrogeologic data. Obviously, the greater the distance from the area of extensive investigation, the greater the uncertainty in how accurately the model reflect actual conditions. Thus, we anticipate that the model most accurately reflects actual site conditions in the vicinity of the interception/extraction systems.

OK will add

17. In Section 7.4.2. of the plan, the 2 years and 2 month stabilization time are not acceptable due to the comments made on computer simulation.

It is not clear in what context the stabilization times are 'unacceptable'. The information is presented to provide the reader some time frame within which steady state conditions would be anticipated. No actions or decisions are based on this estimate. These estimates are only intended as conceptual guidance for identifying anticipated aquifer response time, and is not intended to replace physical and water quality data. The statement can be removed from the Aquifer Management Plan, if desired by the regulatory agencies, but it appears useful provided the reader understands it is only an estimate.

OK

18. Given the amount, complexity and long-term nature of data requirements, the reported data must be in a format that allows computer manipulation and analysis. Ecology outlined this position in a June 14, 1994, letter to the County and included a computerized reporting format. Subsequent verbal communication from the County indicated the format would be followed when groundwater monitoring data is reported. Acceptable reporting of monitoring data must be in this format and should be included in the Aquifer Management Plan.

no floppy rec'd

Spokane County will provide Ecology and EPA monitoring data on electronic media (floppy disk) in a format generally consistent with the reporting format identified in Ecology's June 14, 1994 letter. The format may be modified somewhat from Ecology's identified format to more efficiently present the data, but modifications will be subject to the review and concurrence of EPA and Ecology. These data will be provided in conjunction with project quarterly reports, and the Aquifer Management Plan will be modified to reflect this. The water quality data through the 3rd Quarter 1994 are included with this memorandum. We request that EPA and Ecology inform Spokane County if additional data, or a modified format, is needed.

19. Regarding Section 7.3.2. the decision to modify or adjust operation of Remedial Action is not to be made by the Spokane County project manager. This decision resides with Ecology and the EPA. Please edit the text to reflect that the decision resides with Ecology and EPA.

The Consent Decree requires that Spokane County submit a proposal for system adjustment to Ecology and EPA for review and approval if operational or adjustment control criteria are exceeded. The Aquifer Management Plan text will be modified to reflect this requirement. However, Spokane County should have the flexibility to make minor operational adjustments to the system (i.e., 'fine tuning') without EPA and Ecology concurrence, provided that the adjustments are not driven by the exceedence (or projected exceedence) of any Consent Decree criteria. We request that EPA and Ecology state their position regarding this issue.

20. Quarterly monitoring for water level measurement to evaluate regional impact of the extraction system is acceptable on the condition that we (the governments) approve the extent of monitoring. The extent of monitoring is not defined in the plan.

Section 7.5.2 of the Aquifer Management Plan (page 7-12, first full paragraph) identifies the wells proposed for monitoring the regional impact of the extraction system. We request that Ecology and EPA identify what additional information is needed for their review and approval of the extent of monitoring.

21. Monthly monitoring for drawdown in extraction and monitoring wells is reasonable but comparing it to model predicted drawdowns to estimate the efficiency of capture or to evaluate the need for adjusting the system is not reasonable.

As previously discussed, groundwater quality data from compliance monitoring wells will form the basis for evaluating system performance and adjustments related to Consent Decree requirements. Comparison of observed and model-predicted drawdowns is only intended as an operational tool to assist Spokane County in evaluating whether *the extraction system's hydraulic performance is consistent with that predicted to be necessary to achieve the Consent Decree requirements. In our opinion, this is a very useful tool, and is reasonable, provided the operator recognizes the uncertainties inherent in any computer simulation. If EPA and Ecology do not concur, we request that they identify the manner in which they believe the observed drawdown data should be evaluated.*

OK

22. Regarding section 7.4.2 of the management plan what is the technical rationale, and the assumptions for the 40% and 20% adjustment criteria? What is technical rationale and assumptions for the 120 day-0.1 ft., 60 day- 0.1 ft. and 30 day- 0.1 ft. criteria?

These values are based on Landau Associates' best professional judgement, and are intended to place some bounds on the timing and extent of system adjustments that can be initiated by the operator. In our opinion, the operator should not adjust system flow rates to values that vary more than 40 percent of the model-predicted values without more detailed evaluation of the cause of (or need for) this extensive of an adjustment. The recommendation to exceed the target drawdowns by 20 percent is intended to provide a high level of confidence that capture is being achieved; it is important to remember that target drawdowns are in the range of 0.5 ft to 3 ft, so 20 percent exceedence is only 0.1 ft to 0.6 ft of additional drawdown. The stabilization criteria (120 day-0.1 ft for the Upper Aquifer and 30 day-0.1 ft for the Lower Aquifer) is intended to prevent the operator from making system adjustments prior to the aquifer stabilizing under a given pumping condition. If Ecology and EPA disagree with these guidelines, please identify similar criteria that they believe to be more appropriate.

Oral issue OK

23. Page 7-3, Section 7.2. All of the source control extraction wells are extracting from the Lower Sand/Gravel Aquifer Unit. Does there need to be source controls in the Upper Sand/Gravel Aquifer unit (has it all migrated to the lower aquifer?)?

The Consent Decree scope of work (section I, 3rd paragraph) specifies that the East (source control) System will extract groundwater from the Lower Sand/Gravel Aquifer, and possibly the Latah/Basalt units. Beyond the Consent Decree requirements, groundwater quality data (see attached Figures 1 and 2) indicate that greatly elevated (source) concentrations for the constituents of concern are limited to the lower aquifers. Thus, location of the East System wells in the Lower Aquifers is a Consent Decree requirement and is appropriate based on available data.

OK

24. Page 7-5, Section 7.3.1. The Evaluation Criteria were established because of specific analytical limitations. Practical Quanitification Limits (PQLs) were established for methylene chloride and tetrachloroethylene (PCE) in the consent decree and presented in Table 7-3. However, the Scope of Work attached to the consent decree states (page IV-3, 2nd paragraph) that "If the levels to which these compounds can be accurately quantified (using EPA method 8010) change during the course of the project, Table IV-1 [Table 7-3 in the above Aquifer Management Plan] will be adjusted accordingly." The accepted PQL for methylene chloride is currently 10 $\mu g/l$ (ppb), therefore the Evaluation Criteria, Table 7-3, for methylene should be changed to reflect this.

Landau Associates is unaware of any changes to the PQL for methylene chloride under EPA Method 8010. We request that Ecology provide a specific reference to this change.

We concur that if the method-specified PQL is different from that shown in Table 7-3, the table should be modified accordingly.

25. Page 7-8, Section 7.4.2. It appears that all of the operational adjustments are focused on the target drawdowns that were calculated from the model. There must be other operational controls that are important to manage to optimize the system.

Maximizing contaminant removal while maintaining adequate hydraulic containment is another aspect of optimizing groundwater extraction. This consideration is mentioned in Section 7.4.2 (page 7-9, 2nd paragraph), but only in the context of adjustments required to achieve target drawdowns. It should be recognized that the Aquifer Management Plan is intended for use by the facility operator in the course of day-to-day operations, and is not intended to address adjustment or optimization activities that would require extensive analysis, including computer modeling, to evaluate. We request that Ecology or EPA identify any other optimization suggestions that they believe appropriate in the context of day-to-day facility operation.

OK

26. Page 7-10, Section 7.5; and Figures 7-3, 7-5, and 7-8. The selection of monitoring wells for the Upper Sand/Gravel Aquifer do not appear to adequately monitor contaminant migration in the upper unit. Figure 7-5 illustrates the well locations. No wells are monitoring potential contaminant migration to the southwest, west of U.S. Highway 2 (see Figure 7-3). Private wells are generally not sufficient due to limited access and incomplete/inadequate well construction information and standards. The wells located near the extraction wells (see Figure 7-3) are all within the cone of depression depicted on Figure 7-8 and cannot monitor site contaminants that may be migrating past the capture zone on the east or west sides of the cone.

The Consent Decree specifies the number and relative locations (i.e., downgradient and crossgradient) in relation to the leading edge of the plumes in the Upper and Lower Sand/Gravel Aquifers. The Groundwater Monitoring Plan (Landau Associates 1992b) provides the basis for the selection of the compliance monitoring well locations. In our opinion, the present monitoring system meets the Consent Decree requirements. Additionally, the domestic well program supplements the groundwater compliance monitoring system with significant additional groundwater quality data (as shown on Figures 1 and 3, presented herein), and in our opinion, provides adequate coverage of the plume boundary for the Upper Sand/Gravel Aquifer.

Capture zone vs. cone of depression

In our opinion, the cone of depression (Figure 7-8) is not directly relevant to the capture zone. Perhaps the commentor intended to reference the capture zone figure (Figure 7-6). As previously discussed in response to comment 3, there are physical limitations that make it impractical to locate crossgradient monitoring wells in the Upper Sand/Gravel Aquifer so that they can function as both a potential extraction well and be outside the zone of capture. As identified in Ecology's April 27, 1992 comment letter on the Groundwater Monitoring Plan (Ecology comment 7), the probable result of locating the crossgradient monitoring wells within the capture zone is increased contaminant concentrations in these wells, which would appear to be more, rather than less, protective of human health and the environment. Also, comparison of the extent of the affected area and the location of monitoring wells and domestic wells on Figures 1 and 3 (attached) to Figure 7-6 indicates that a number of monitoring points are present

down gradient ✓.
cross gradient

outside the zone of capture along the west boundary of the plume, and that the capture zone on the east side of the plume extends well beyond the affected area. These conditions appear to provide a high level of confidence that the monitoring system not only meets, but exceeds, the intent of the Consent Decree.

27. Page 7-10, Section 7.5.1, suggests the use of indicator compounds for monitoring the ground water. This practice is acceptable provided the correct indicators are selected and periodically a full analysis is done. The indicator compounds selected (4) do not include methylene chloride which is a major contaminant of the Lower Sand/Gravel Aquifer and was also a significant factor in the establishing the design parameters for the treatment facility. Monthly instead of annual data on the methylene chloride concentrations would seem to make sense not only as an indicator compound but also as an operational parameter.

MC not included as indicator

The four indicator compounds are the four identified in the Consent Decree scope of work (see Sections V.A.2.a and V.C.2.a). The Consent Decree specifies that methylene chloride and PCE will be analyzed annually for at least the first 5 years of operation, but do not form the basis for interception system design or operational criteria. In our opinion, analysis for methylene chloride and PCE more than once a year is at the discretion of Spokane County. It should be noted that Spokane County has been analyzing all groundwater samples for the full list of EPA Method 8010 compounds, which include all six constituents of concern. This comment does not appear to necessitate a revision to the Aquifer Management Plan. *

APPENDIX E, FIELD SAMPLING PLANS

1. Page E-3, Section 3.0. The location of each monitoring well in Table E-2 only addresses a single point in the aquifer. What about the vertical profile in the thick Lower Sand/Gravel Aquifer?

ok

There are three wells at each West System groundwater compliance monitoring location that are screened at different depths within the Lower Sand/Gravel Aquifer. The text will be revised to clarify this point.

2. Page E-6, Section 4.1.5, last paragraph. The Chain-of-Custody Record should be in triplicate instead of duplicate if you require 2 file copies; i.e., analytical laboratory, project file, and QA Coordinator.

ok

We concur. The text will be modified accordingly.

3. Page E-10, Section 4.2.3, first paragraph, second sentence. It stated that a non-dedicated bailer or pump will [*sic*] decontaminated with several washes "following use." The decontamination needs to occur before use and rinsed after use. The decontamination procedures then need to be done again before that piece of equipment is used again for sampling.

ok

We concur, with respect to decontamination of bailers and pump externals. However, we find it more efficient to decontaminate pump and tubing internals following sampling *and leaving the pumping system filled with deionized water following decontamination. Because the water is maintained internally, it is not subjected to potential contamination. This method was used throughout previous site investigations, and no cross contamination or field rinsate blank contamination resulted. We request that EPA and Ecology review this proposed modification and inform Spokane County whether it is acceptable.*

OK.

COMPUTER SIMULATION COMMENTS

1. Regarding the data base for computer modeling, the data base for the upper aquifer appears to be a single set of water levels collected from March 28, 1990 through April 12, 1990. The data base for the lower aquifer appears to be a single set of water levels collected from January 21, 1990 through January 17, 1990. There are two critical problems with this data base:

   A. Regarding upper aquifer water levels, it is standard operating procedure in hydrogeological investigations of unconfined aquifers to collect water levels for contouring purposes within a period of 48 hours or less. This window of measurement serves to eliminate time dependant variability due to precipitation, percolation and potential barometric effects.

   Water levels in the upper aquifer were collected over a period of two weeks. We do not believe that time dependant variability is addressed in this collection, and, therefore, contend that water table contours generated from this data are invalid. Consequently, the calibration of the computer model is inadequate.

   A valid water table contour map for calibration purposes would be comprised of water levels collected within a two day period with a notation of precipitation that has occurred two days prior to, and during the period of measurement. We suggest that to determine a valid water table contour map for simulation purposes that the County follow this procedure twice over a period of one year, once during the low water levels and once during the high water levels.

   If the County wishes to contend that the water table contours are valid please reference instances, other then the Colbert project, where regulating authorities charged with protecting groundwater have accepted as valid unconfined water table contours of a contaminated aquifer generated from data collected over a two week period.

   B. Regarding hydrogeological investigations, it is standard operating procedures to estimate/quantify groundwater flow with at least two measurement events taken in one year, during a period of high water level and a period of low water level, and that some comparison be made to water levels in other years.

   The data base for calibrating aquifer simulation consists of a "snapshot" of water levels taken during a short period during 1990. It is very possible that the relationship of water levels in the measured wells varies with the seasons and thus the flow direction would change with the seasons. Perhaps 1990 was a "freak" year for water levels. We do not believe a single "snapshot" of water levels measurements constitutes a valid data base for either representing the flow pattern or computer simulation of the flow pattern.

A valid data base for computer simulation would consist of several measurements taken on a seasonal basis. We suggest the County either do this or show by means of a hydrograph for several wells that the "snapshot" is representative.

If the County wishes to contend that the water table contours are valid please reference instances, other then the Colbert Project, where regulating authorities charge with protecting groundwater have accepted as valid unconfined water table contours of contaminate aquifers generated from data collected over a two week period.

The commentor raises two valid issues:

- *Are groundwater elevation data collected over a 2-week period appropriate for use in characterizing the potentiometric surface for an unconfined aquifer?*

- *Does a single round of groundwater elevation data provide an adequate database for modeling groundwater flow, considering the potential seasonal variation in groundwater elevation and flow conditions (flow direction and gradient)?*

We will address both of these questions, with the intent of demonstrating that the groundwater elevation data used for modeling the Upper Sand/Gravel Aquifer are adequately representative for calibration of the numerical groundwater flow model.

In addressing the first question, we believe it relevant to address both why the data were collected over a 2-week period and why the data are adequately representative. We concur that ideally the data would be collected over a 2- to 3-day period. However, the extensive area over which the data must be collected (about 2.5 square miles), and the need to coordinate measurement of water elevations from numerous domestic wells with the property owners, have made collection of a comprehensive round of water levels within less than about a 2-week period impracticable. In many instances, obtaining a water level from a domestic well requires an appointment with the property owner, often after regular business hours. It has been necessary to arrange appointments over about a 2-week period to accommodate the schedules of the various property owners.

Regardless of why it generally takes about 2 weeks to obtain a round of groundwater levels, it is necessary to demonstrate that significant water level fluctuations do not occur within the collection period. There is extensive evidence for both the specific period of interest (March 28 through April 12, 1990) and in general terms, that groundwater elevations in the Upper Sand/Gravel Aquifer do not fluctuate significantly. Figure ER.21 from the Phase I Engineering Report presents river stage data for the Little Spokane River and groundwater elevation data for monitoring wells CD-40C1 (Fluvial Aquifer) and CD-40C2 (Lower Sand/Gravel Aquifer) for February through September 1990.

As illustrated in the figure, neither river stage nor groundwater elevation fluctuated significantly for the period of interest. Although neither well is screened in the upper Sand/Gravel Aquifer, any significant recharge event (rainfall or snow melt) would be reflected in river stage and groundwater elevation. In fact, the depth to water in the Fluvial Aquifer (about 9 ft) is significantly shallower than the depth to water in the Upper Sand/Gravel Aquifer (about 80 ft), and consequently, would be expected to respond more rapidly to any recharge events.

Additional evidence regarding the minimal water elevation fluctuations exhibited by the Upper Sand/Gravel Aquifer is provided on Figure ER-4.16 of the Phase I Engineering Report, which presents hydrographs for monitoring wells CD-3M (Upper Sand/Gravel Aquifer) and CD-3L (Lower Sand/Gravel Aquifer). Although the record for CD-3M is incomplete, it is obvious from the available data that the Lower Aquifer water elevations have greater fluctuations than the Upper Aquifer levels, and that the water elevation fluctuation in the Lower Aquifer for the subject period is less than 0.1 ft.

The potential water elevation fluctuations for a measurement round need to be placed in the context of the water elevation change throughout the aquifer. Groundwater elevations decrease from elevation 1773 ft (MSL) in the landfill vicinity to 1757 ft at the south end of the site, a change of about 16 ft. A potential variation of about 0.1 ft within the measurement period is negligible in this context.

The commentor is correct in pointing out that a single round of groundwater elevation data are inappropriate for use in modeling groundwater flow, due to potential seasonal fluctuations. Landau Associates evaluated groundwater elevation data from six rounds of water levels collected between August 1989 and November 1990. These data are presented in Table ER-3.1 of the Phase I Engineering Report, and are reproduced in Table 1 presented herein. Also presented in Table 1 are data from a June 1993 measurement round to allow comparison over multiple years.

The March 28 through April 12, 1990 round of water elevation data were used for modeling purposes because they represent the most comprehensive round of water elevations collected for the project, and because the data strongly support the conclusion that water elevations do not vary significantly on a seasonal basis, or from year to year. This conclusion is based on the data discussed in response to the first question posed in this comment and the data in Table 1. With the exception of two measurements, including one that appears to be erroneous (b) (6) *, August/September 1989), the maximum difference between the April/May 1990 measurement round and any other measurement round is less than 1 ft. These data indicate that seasonal and annual fluctuations in the Upper Sand/Gravel Aquifer groundwater elevations are minimal, particularly when considered in conjunction with the data presented earlier in this response.*

In our opinion, the preceding response adequately addresses the comment, and demonstrates that the groundwater elevation data used for developing and calibrating the Upper Sand/Gravel Aquifer flow model were appropriately applied. The commentor also requested that Spokane County identify other sites where regulatory agencies have accepted groundwater data collected over a 2-week period for preparing groundwater contours. In our opinion, the data for each site should be evaluated based on its own ok *merits, and extensive data have been presented to justify the use of the subject data for the Colbert Landfill site. If EPA and Ecology require demonstrations of similar applications on other projects, extensive research may be required because the level of detail required (i.e., the time period over which water levels are collected) are not readily available from public domain databases or similar information sources for other sites.*

2. An assumption critical to the simulation is that the Lacustrine Aquitard extends beneath the river and thus controls river conductance. However, it is reasonable to assume that the aquitard might not be beneath the river or that the River eroded the aquitard. We believe this to be a critical unsubstantiated assumption and would require geologic evidence to support the assumption (i.e., borehole geology) if computer simulation were used for compliance purposes.

   If the County is in disagreement please either provide a computer simulation of the lower and upper aquifer in which the Aquitard is absent, or a technical discussion on why the absence of the aquitard would not significantly impact the present computer simulation.

   As the commentor is probably aware, it is very difficult to accurately determine the hydraulic conductance between an aquifer and a river. Even if specific measurements are made, there is typically a high level of variability between measurement locations due to various factors associated with river bed conductance and variable aquifer/aquitard properties. The presence (and thickness) or absence of the aquitard was modeled implicitly by varying the river bed conductance. The model was then calibrated to groundwater elevation data, and to river recharge data provided in an Ecology publication (Ecology 1975). The ability of the model to achieve adequate calibration with groundwater elevation targets and target discharge to the river, provides a level of calibration that is often unavailable for many groundwater models because of the higher level of uncertainty with respect to river discharge or recharge.

   OK check w/ Mike *The commentor requests that it be demonstrated that the model is not sensitive to the presence or absence of the aquitard beneath the river. In our opinion, this is not feasible because the groundwater model cannot be calibrated to observe groundwater elevation conditions and known boundary conditions (i.e., groundwater flux to the river) without using variable river conductances (i.e., variable aquitard presence/thickness beneath the river). In other words, the model is sensitive to the presence or absence of the aquitard beneath the river.*

   It is common modeling practice to make a best estimate, initial calculation, and then adjust the values during calibration. This approach was used for the Lower Aquifer model, with Ecology's flow (recharge) data for the Little Spokane River used as the calibration target. We are aware of very few regional groundwater flow models that have obtained or developed more accurate calibration targets for river conductance; however, doing so certainly goes beyond anything that would be considered standard practice for most groundwater modeling applications.

3. The upper aquifer and lower aquifer are hydraulically connected because contamination in the upper aquifer has flowed into the lower aquifer. MODFLOW has the ability to model both aquifers in a single simulation. For the investigation two simulations were used, one for the upper aquifer and one for the lower aquifer. In effect the aquifers were

modeled separately. We believe that modeling both aquifers together would provide a more accurate representation. Section 4.0 of the Final Extraction Well Plan provides no explanation on why the aquifers were not modeled together. What is the rationale for not modeling the aquifers together? What is the assessment on decreased accuracy in simulation due to not modeling the aquifers together?

answered ok?

The upper and lower aquifers were simulated using two separate models. The models were linked by using values of flux out the bottom of the upper aquifer model as input via recharge into the lower aquifer model. This approach was used primarily due to hardware and software limitations at the time of the modeling activities, and in our view is as valid as combining the models into one. The mechanisms for contaminant flow from the upper to the lower aquifer involve complex geologic conditions along the eastern margin of the former landfill.

4. Regarding model boundary conditions, we do not find a satisfactory explanation for the model's eastern boundary in the vicinity of the landfill. We refer to the boundary explanation in section 4.2.1. of the final extraction well plan. As drawn in figure B-4 of the plan, the upper aquifer is terminated within the confines of the landfill, and does not exist to the south east of the landfill. However, cross sections of the upper aquifer in figures ER 4-4 and ER 4-5 of the plan show that the upper aquifer extends for a considerable distance east of the landfill. In Section 4.1 it is stated that drawdown does extend to some model boundaries but the impact is minimal. Please provide the technical basis for the assessment of minimal impact of the eastern boundary on drawdown, and include the drawdown. Please identify where drawdown has extended to other boundaries and include the drawdowns.

rational OK

Although the Upper Sand/Gravel Unit extends a significant distance to the east of the landfill, the Lacustrine Unit (which forms the aquitard at the base of the Upper Sand/Gravel Aquifer) is discontinuous or not present east of the landfill. Thus, the Upper Sand/Gravel Aquifer only extends to about the eastern edge of the landfill, as represented on Figure B-4 of the Phase II Extraction Well Plan, Appendix B (Landau Associates 1992b).

Upper aquifer drawdown as much as 1.5 ft occurs at the eastern model boundary in the vicinity of the South Extraction system. Since this boundary was modeled as a general head boundary with relatively high conductances, the effect of the boundary was minimized. The shape of the drawdown cone is not skewed on the west as compared to the east which also supports this conclusion.

5. Regarding upper aquifer modeling, we do not find in Section 4.3.1 of the Final Extraction Well Plan an accounting of the impact of Deep Creek in the southern boundary conditions. Deep creek's impact can be significant because of it's [*sic*] proximity to the extraction well field. Regarding upper aquifer modeling, a general head boundary was used to simulate the model's southern boundary. How does the general head boundary take into consideration the impact of Deep Creek on the upper aquifer? What is the impact of Deep Creek on the head in the upper aquifer in the vicinity of the Southern boundary of the computer model?

Limited data are available regarding the interaction between Deep Creek and the Upper Sand/Gravel Aquifer. However, the following data and available information suggest that the impact is minimal:

- *Deep Creek has a stream bed elevation of about 1820 ft (MSL) in the area of interest, which is at least 60 ft above the groundwater elevation for the Upper Sand/Gravel Aquifer. Thus, Deep Creek does not function as a recharge or discharge boundary.*

- *Deep Creek is a perennial stream east of Highway 2 that maintains a low but constant flow rate through the summer (this statement is based on visual observations rather than on flow measurements), which indicates a limited conductance between the creek and the Upper Sand/Gravel Unit.*

- *Groundwater flow in the Upper Sand/Gravel Aquifer is toward the southeast (toward Deep Creek), which suggests that Deep Creek does not significantly impact groundwater flow in the vicinity of the South Interception System.*

Ok

This information strongly suggests that Deep Creek does not constitute a major boundary, or a major recharge or discharge source. The general head boundary does not directly account for Deep Creek, but provides a mechanism for model recharge that should adequately address recharge from Deep Creek given its apparently minimal impact to the Upper Sand/Gravel Aquifer in the vicinity of the South Interception System.

6. Regarding the western boundary of the upper aquifer, there would be flow out of the aquifer (bluff face) simply because there is nothing to stop flow and there is no structural feature to deter flow. Why then, was the western boundary modeled as a no flow boundary?

   A review of groundwater elevation data for the upper aquifer suggested that flow was primarily to the south with some local components of flow over the bluff, mainly via springs. The model used wells to remove water at the locations of observed springs to account for the localized flow to the west.

   However, we disagree with the commentor's conclusion that there is no structural control that prevents the migration of groundwater in the Upper Sand/Gravel Aquifer. Figure ER-4.13 from the Phase I Engineering Report presents elevation contours for the top of the Lacustrine Aquitard, which forms the base of the Upper Sand/Gravel Aquifer. It is clear from this figure that groundwater flow is largely structurally controlled by the Lacustrine Aquitard surface, which directs the majority of flow to the south and southeast.

Ok

7. MODFLOW has several options for boundary conditions. For all boundary conditions selected for modeling the lower and upper aquifer we would like to see the rationale for selection in terms of boundaries rejected. What is the rationale for selecting the boundaries?

Boundaries in MODFLOW can be modeled as constant head, constant flux (injection or extraction wells, or no flow), or variable head and flux (general head). The boundaries used for the upper and lower aquifer models are shown on Figures B-6 and B-7 of Appendix B to the Extraction Well Plan.

ok

The upper aquifer boundaries consist of general head boundaries for the north, east, and south to allow for flow across them. No flow boundaries were used for the west, and a portion of the east, to simulate the edge of the aquifer. The northern boundary was set as constant head since the head can be estimated from groundwater elevation data and the boundary is far from pumping locations. The southern and portions of the eastern boundary were modeled as general head to allow for flux and head to change in response to pumping. Drains were added to the eastern boundary in the vicinity of the landfill to represent flow into the lower aquifer, and to the southeast to represent discharge from the aquifer as suggested by water level information. The western boundary was modeled as no flow with wells to represent flow out of the springs. The southeast boundary was also modeled as no flow due to the presence of a granite bedrock highland boundary in that area. The top of the model was simulated with recharge, and the bottom was controlled with vertical conductance terms.

The lower aquifer's eastern boundary was modeled as constant flux simulating recharge from further up the valley and from spillover from the upper aquifer. The northern boundary is perpendicular to flow and was modeled as no flow. The southern boundary was initially considered to be perpendicular to flow and was modeled as no flow, but was later changed to a flux boundary when calibration to measured water levels suggested some flow across the boundary. The western boundary was modeled as general head to allow for head and flux to change because little information was available for that area, and because the primary point of discharge for the lower aquifer is the Little Spokane River which was modeled with river cells. The bottom of the aquifer was modeled as no flow, and the top was modeled with recharge simulating flow from the aquitard, which was adjusted based on flux values from the bottom of the upper aquifer model.

ok

8. The modeled groundwater contours and the measured groundwater contours are represented on different figures separated by several pages of text, making it all but impossible to meaningfully compare the two sets of contours. In many reports the two sets are superimposed. We would like to see the measured groundwater contours for each aquifer superimposed on the modeled groundwater contours for each aquifer. The measured contours are already plotted in figures B-2, B-3 of the Final Extraction Well Report. The modeled contours are also plotted as Figures B-15 and 16 of the report. All that is needed is to superimpose Figure B-2 on Figure B-15 and to superimpose figure B-3 on Figures B-16. Please superimpose the figures.

We have prepared the figures, as requested by the commentor. They are provided herein as Figures 5 an 6 for the Upper and Lower Sand/Gravel Aquifers, respectively. As can be seen from these figures, the head matches are generally in good agreement between the measured and model-predicted heads, although there is some divergence in flow direction for the Upper Aquifer to the south of the interception system.

ok

9. We are concerned about contamination breaking through the east\west extraction systems. In the County's technical memorandum for modifications to the extraction system (October 1993), Section 4.2.2 states that four computer simulations using MODFLOW and PATH3D were used to model the west/east extraction systems with the elimination of extraction wells CP-W4 and CP-E4. The section concludes that capture can be accomplished without CP-W4 and CP-E4, and refers the reader to the Figures 9 through 12. However, figures 9 through 12 all show a particle path that passes through the west/east system and proceeds to the Little Spokane River. In essence, the model results do not appear to show capture. Please respond to our observation that Figures 9 through 12 show contamination breaking through the extraction well system. What is the flux and concentration of the particle path that breaks through the extraction well system? There are also particles beyond the southern boundary of the capture system. What is the flux and concentration of these particle break throughs?

The particle tracks represent the edge of the capture zone, not breakthrough. Two particles were released to both the north and the south of the landfill. The inner particle (the one closest to the landfill) was captured by the interception system and the outer particle migrated downgradient, thus defining the edge of the capture zone. The particles are not directly related to a specific concentration or flux, but to an area of capture. Comparison of the areal contaminant distribution on Figure 7 of the subject memorandum to the capture zones identified on Figures 9 through 12 indicate that all the groundwater exhibiting concentrations above the performance standards will be intercepted by the West Interception System.

ok?

10. Dispersion must be accounted for. The simulation should at least account for transverse dispersion to identify the width of the contaminant plume for determining monitoring well locations. Why would transverse dispersion not be a factor in plume width? Why was transverse dispersion not accounted for in the simulation? Design concentrations for the treatment system should not impact this issue because design data can be obtained from analytical data, and therefore would not require computer modeling.

Capture zone analysis, which is the interception system design method specified in the Consent Decree, does not account for dispersion in the movement of individual particles. However, the capture zones were developed that extend capture beyond the lateral boundaries where groundwater concentrations exceed the performance standards. Thus, the model provides a margin of error that will accommodate reasonable lateral dispersion. It should also be recognized that the potential for lateral dispersion is significantly less under groundwater extraction than under natural flow conditions.

ok

11. We are unable to confirm or validate critical input parameters because their development/derivation is not identified or referenced. These parameters include:

A. vertical permeability of the upper aquifer estimated to be 4E-4 ft/day;

As referenced on page B-4, the permeability of the aquitard was estimated from data in the Golder (1987) report.

B. leakage from the aquitard into the lower aquifer estimated to be 0.14 to 10 ft cubed/day;

? *Leakage from the aquitard was estimated based on model-predicted flow out the bottom of the upper aquifer model following calibration of that model.*

C. the K values of 530 and 410 ft per day and the K values of 640 to 500 ft/day;

? *The hydraulic conductivities of 530 and 640 ft/day represent the upper and lower bound estimates for the Upper Sand/Gravel Aquifer, based on the Phase I pumping test for CP-S1 (see Table ER-4.1 from the Phase I Engineering Report). 640 ft/day was used as the upper end hydraulic conductivity for the upper bound flow scenario and 530 ft/day was used as the upper end hydraulic conductivity for the lower bound flow scenario. The lower end hydraulic conductivities for each flow scenario are equivalent (on a percentage basis) to the reduction in hydraulic conductivity between the 640 and 530 ft/day estimates.*

D. K values of 200 and 270 ft/day and K values of 110 to 180 ft/day;

These values are in general accordance with the range in hydraulic conductivity estimated for the Lower Sand/Gravel Aquifer (100 to 230 ft/day) from the Phase I investigation (see Table ER-4.1 from the Phase I Engineering Report), except that the hydraulic conductivities for the upper bound flow scenario were increased by between 20 and 40 percent to ensure that the pump and treat system would have sufficient capacity for any reasonable potential flow rate.

E. the delineation of the zones of high and low K;

These delineations are based on the results of the Phase I pumping tests for the lower aquifer, which indicates a higher hydraulic conductivity to the west (CP-W1 pumping test) compared to the east (CP-E1 pumping test). The delineations for the Upper Sand/Gravel Aquifer are more qualitative, and are based on coarser material observed during drilling (CP-S1) near the center of the erosional channel, versus the finer grained materials in outlying borings (CD-31 and CD-32). Additionally, the depositional environment for both the Upper and Lower Aquifers would suggest material variability consistent with that used in the models.

F. the K value of 0.7 ft/day and the conductance of 150 to 1500 day E-1;

OK *The K value of 0.7 ft/d assigned to the river bed is typical of sandy silt material. The conductance term was calculated based on an assumed thickness, and was adjusted during calibration to observed water level contours and river flow data, as previously described in response to comment 2 of this section.*

G. However, transient runs were calibrated for the Upper Aquifer Model and a satisfactory match between model-predicted and observed drawdown at the (b) (6) [redacted] well was achieved;

The models were not developed (i.e., calibrated) to run in transient mode. However, limited transient runs were performed to correlate model data to observed drawdown data from the (b) (6) [redacted] well that was collected during the CP-S1 pumping test. This was accomplished by instructing the model to provide time versus drawdown data for the model cell containing the (b) (6) [redacted] well. The data was then compared to the time versus drawdown data collected from the (b) (6) [redacted] well during the pumping test. Unfortunately, Landau Associates did not retain a printout of this model run in its file. It could be recreated, if necessary.

H. The average K, average gradient and the area for the groundwater flux estimates in Table B-4.

The average K is an average of the upper and lower bound K values, the gradient is from observed groundwater elevation contours, and the area is for the boundary as specified in the table.

We ask for the calculations for the above be presented in a manner that enables verification.

In our opinion, the preceding responses (including reference to existing documents) provide adequate documentation. We request that EPA and Ecology identify any required additional information in support of their original comments.

REFERENCES

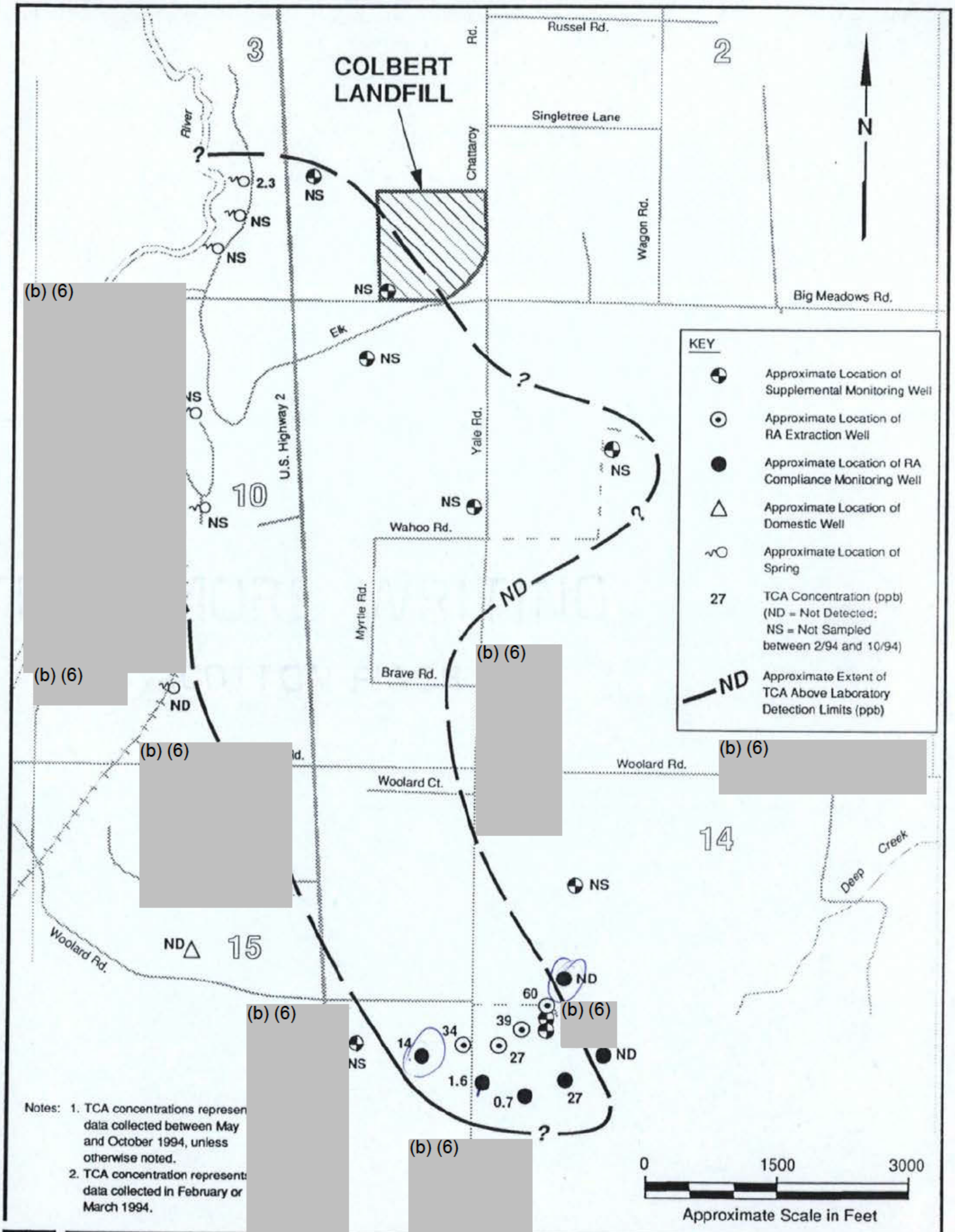
Golder Associates. 1987. Remedial Investigation (RI) Report for the Colbert Landfill, Spokane, WA. Volume I. Prepared for Washington State Department of Ecology.

Landau Associates, Inc. 1991. Final Phase I Engineering Report, Colbert Landfill Remedial Design/Remedial Action, Spokane, County, Washington.

Landau Associates, Inc. 1992a. Final Phase II Groundwater Monitoring Plan, Colbert Landfill Remedial Design/Remedial Action.

Landau Associates, Inc. 1992b. Final Phase II Extraction Well Plan, Colbert Landfill Remedial Design/Remedial Action.

Washington State Department of Ecology. 1975. Little Spokane River Basin, Water Resources Management Program.



Upper Aquifers
Approximate Extent of TCA

Figure 1

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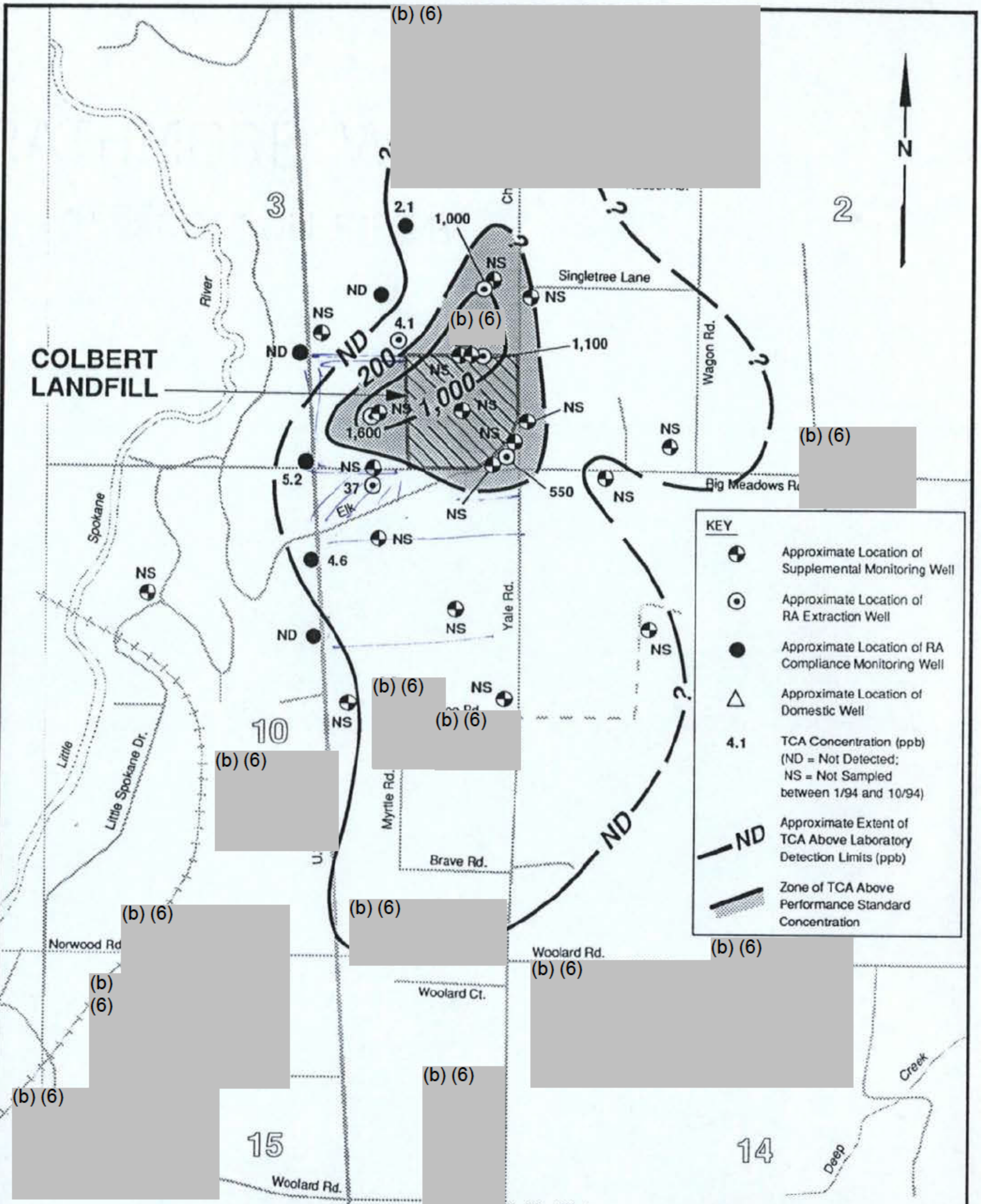

Notes: 1. TCA concentrations represent data collected between May and October 1994, unless otherwise noted.
2. TCA concentration represents data collected in January, February, or March 1994.

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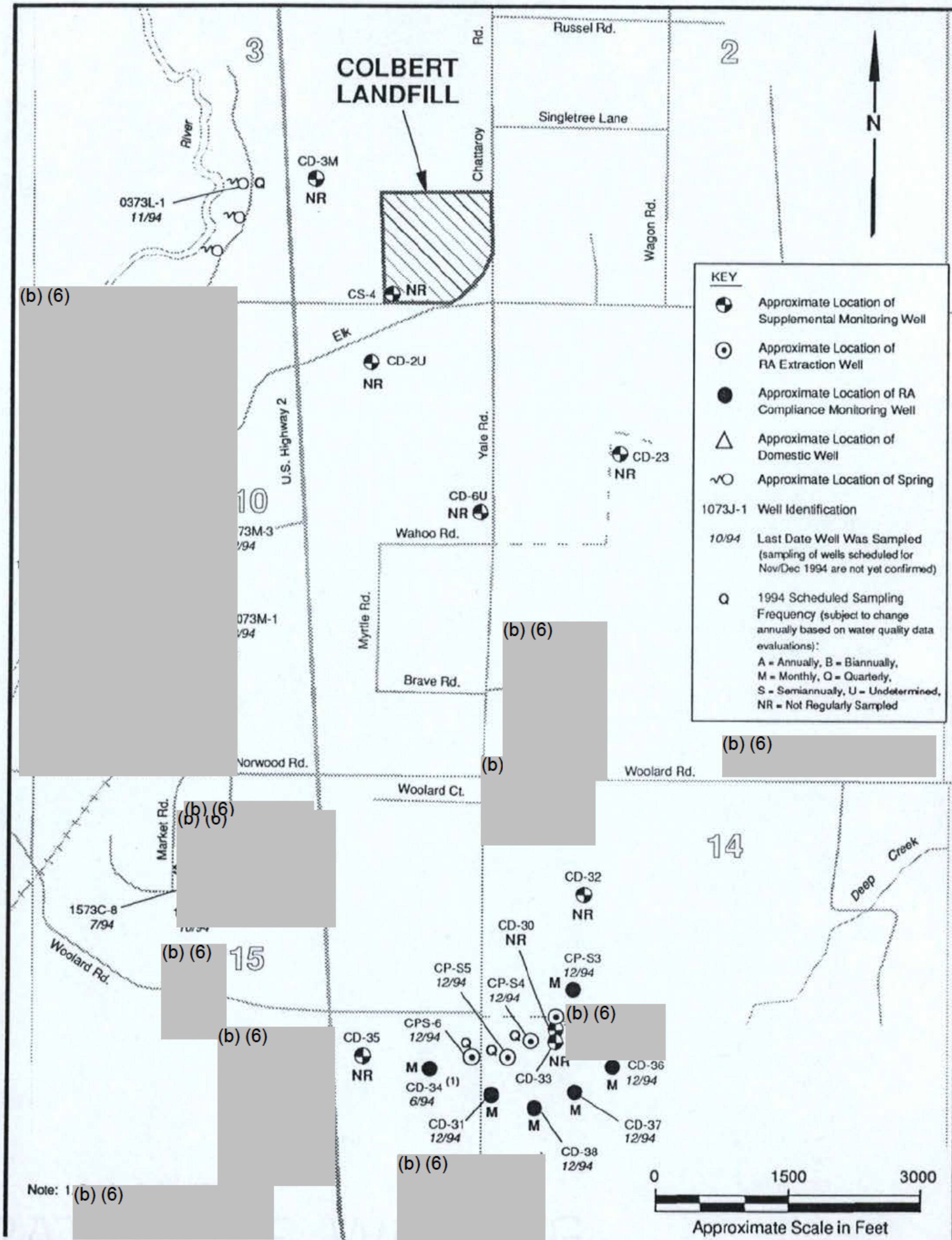
Lower Aquifers
Approximate Extent of TCA

Figure 2



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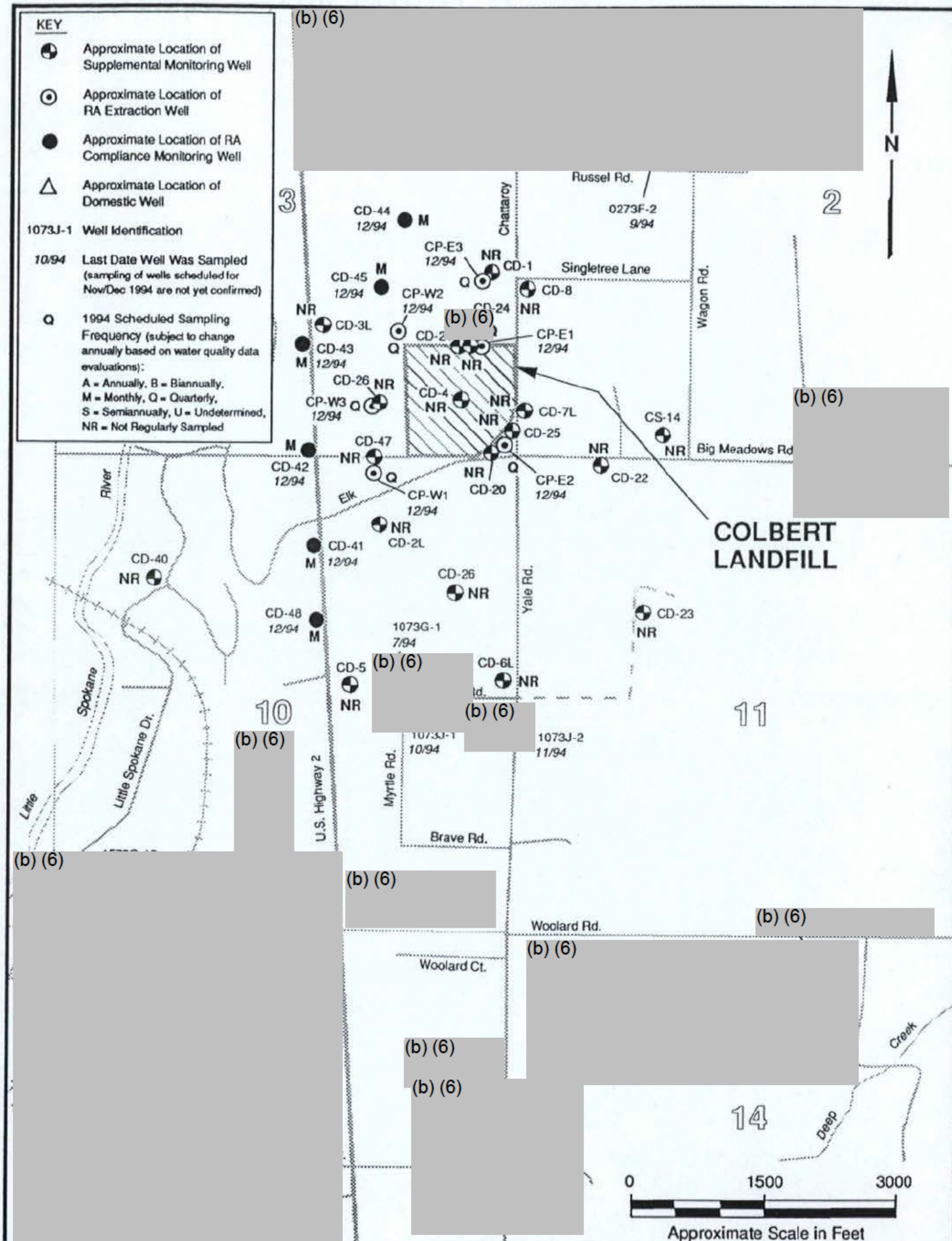
Upper Aquifers
Well Locations and Sampling Frequency

Figure 3



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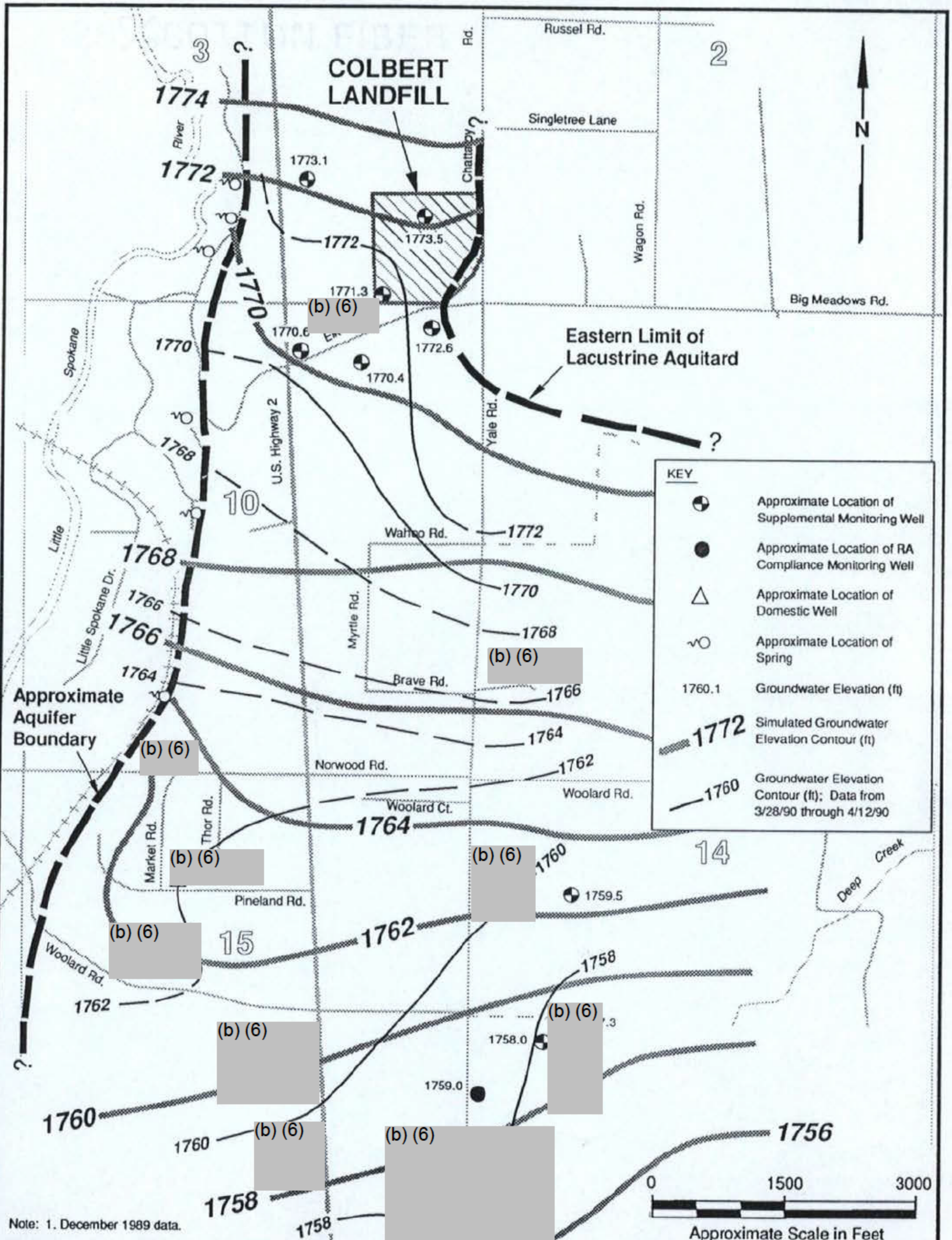
Lower Aquifers
Well Locations and Sampling Frequency

Figure 4



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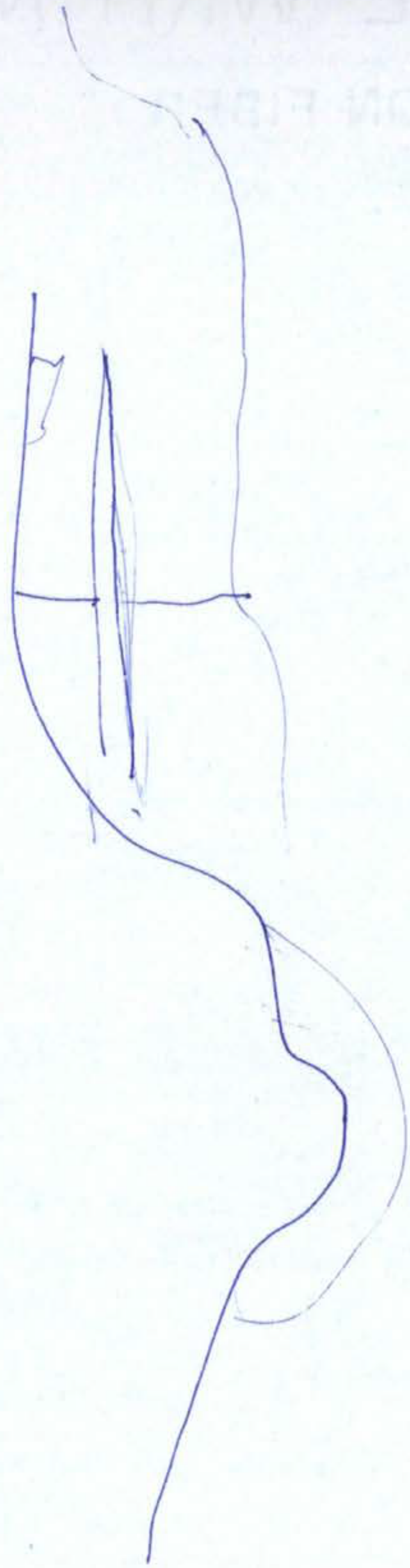
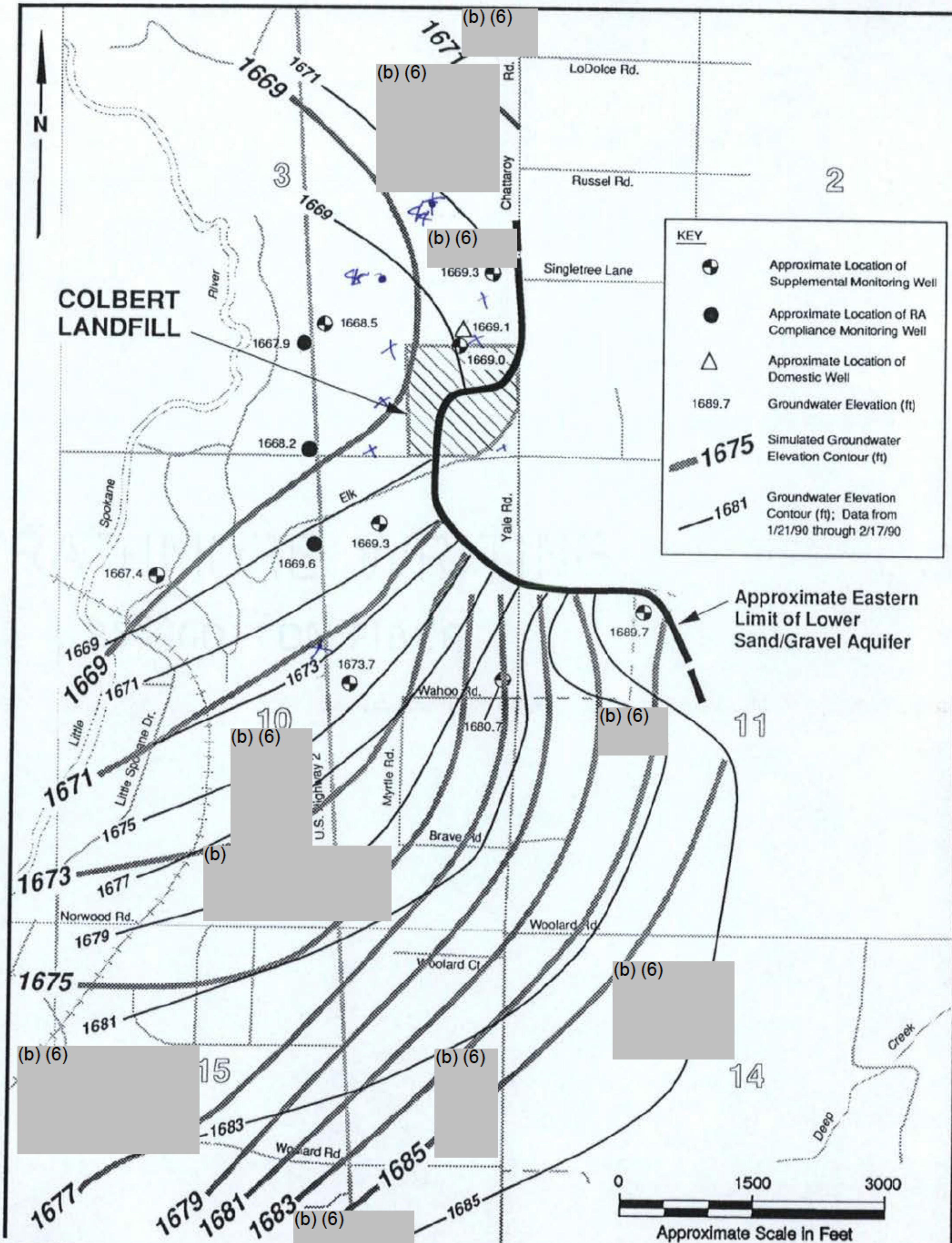
Upper Sand/Gravel Aquifer
Model and Actual Groundwater Elevation Contours (Nonpumping)

Figure 5





Lower Sand/Gravel Aquifer
Model and Actual Groundwater Elevation Contours (Nonpumping)

Figure 6

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TABLE 1

UPPER SAND/GRAVEL AQUIFER GROUNDWATER ELEVATION DATA[a]

WELL	DATA COLLECTION PERIOD 8/28/89-9/13/89	10/4/89-12/19/89	2/14/90-2/28/90	3/28/90-4/12/90	7/18/90	9/6/90-11/12/90	06/93	Average[b]	Maximum Difference[c]
CD-2(U)	——[d]	——	1770.46	1770.44	1770.52	1770.40	1771.30[e]	1770.62	0.86
CD-3(U)	——	——	1798.67	1798.69	1798.63	——		1798.66	0.06
CD-3(M)	——	1773.37	1772.90	1772.99	1773.11	1773.02	1773.30	1773.12	0.38
CD-6(U)	——	1772.39	1772.22	1772.23	1772.30	1772.31	1772.40	1772.31	0.17
CD-23B1	——	——	1781.42	1781.57	1781.55	——		1781.51	0.15
CD-30A	——	——	1757.95	1757.95	1757.92	1757.89		1757.93	0.06
CD-31A	——	——	1759.00	1759.04	1759.70	1759.68	1759.80[e]	1759.44	0.76
CD-32B1	——	——	1759.56	1759.54	1759.00	1759.11		1759.30	0.54
CD-33A	——	——	——	——	1757.93	1757.94		1757.94	
CP-S1	——	——	——	——	1758.15	1758.00	1858.30	1758.08	
CS-2	——	——	——	——	DRY	——			
CS-3	——	——	——	1773.49	1773.58	——	1774.6	1773.89	1.11
CS-4	——	——	——	1771.28	1771.43	1771.36	1771.80	1771.47	0.52
CS-10	——	——	——	1770.61	1770.68	——		1770.65	0.07
CS-13	——	——	——	1772.55	1772.58	——		1772.57	0.03

TABLE 1

UPPER SAND/GRAVEL AQUIFER GROUNDWATER ELEVATION DATA[a]

WELL	DATA COLLECTION PERIOD 8/28/89-9/13/89	10/4/89-12/19/89	2/14/90-2/28/90	3/28/90-4/12/90	7/18/90	9/6/90-11/12/90	06/93	Average[b]	Maximum Difference[c]
(b) (6) [redacted]	—	1759.90	—	1759.75	—	1759.73	1759.90	1759.82	0.15
	1756.99	1757.17	—		—	—		1747.36	
BN-1	—	—	—	1770.95	—	—		1770.95	
(b) (6) [redacted]	1758.57	1758.80	—	1758.49	—	1758.48		1758.59	0.31
	1757.43	1757.44	—	1757.29	—	1757.25	1757.40	1757.36	0.15
	1760.19	1760.27	—	1760.05	—	1760.13		1760.16	0.22
	1758.04	1758.06	—	—	—	—		1758.05	
	1763.15	1763.43	1762.47	1762.82	—	1763.14		1763.00	0.61
	1762.68	1762.69	—	1762.62	—	—		1762.66	0.07
	1760.58	1761.05	—	1760.46	—	1761.02		1760.78	0.59
	1759.23	1760.03	—	1759.93	—	—	1760.0	1759.80	0.1
	1767.59	1767.63	—	1767.31	—	—		1767.51	0.32
	—	—	1760.32	1760.18	—	—	1760.4	1760.30	0.22
	1761.37	1761.38	—	1761.35	—	—	1761.4	1761.38	0.05
	1760.81	1761.01	—	—	—	—		1760.91	
	1766.17	—	—	1762.02	—	—	1762.4	1763.53	4.15

(a) Elevation in feet above sea level (MSL) based on 1929 National Geodetic Vertical Datum.

(b) Average of all water elevation measurements.

(c) Maximum difference between 3/28/90-4/12/90 measurement and any other measurement presented in this table.

(d) Groundwater elevation not measured.

(e) Data are from an average of two measurements taken June 1993 and April 1994.

(f) Former owner.